

Environment and energy topics at a glance

Dioxins and Furans

Dioxins and furans are two families of related chemical compounds known as polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans. Of these, 17 (including the most toxic, 2,3,7,8-TCDD) pose a major health risk.

Similar in chemical structure and biological properties, dioxins and furans are usually

found together in the environment as complex mixtures. The toxicity of each compound depends on the number and position of the chlorine atoms within the molecules.

Why all the concern?

For many people, the word dioxin provokes fear because it has often been described as one of the most toxic substances known to man. Much of this concern has focused on the most toxic member of the dioxin and furan family - 2,3,7,8-TCDD. This was the contaminant in the weedkiller 2,4,5-T, also used by the U.S. military in 'Agent Orange', and in the oil sprayed on the unpaved roads of Times Beach, Missouri, in the early 1970s.

Although most can be broken down by sunlight, dioxins and furans are not biodegradable. They do not dissolve in water and can attach to particles of soil, dust and sediment. As a result, they can persist unchanged in the environment, mainly in soil and sediment, for years. They also can accumulate in animals, wildlife and human body tissues.

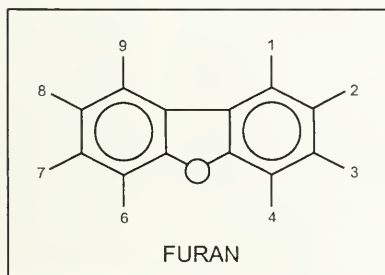
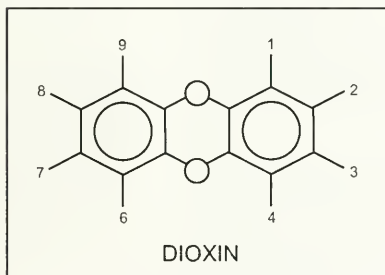
Effects on animals

Extensive laboratory animal testing has shown that 2,3,7,8-TCDD, even at low doses, can cause a number of serious health problems:

- * weight loss
- * skin disorders
- * immune system damage
- * impaired liver function
- * altered blood function
- * impaired reproduction/birth defects
- * increased incidence of tumors
- * increased enzyme production

Studies show that dioxins and furans are present in trace amounts throughout the environment. Minute amounts may be found in the air we breathe, food we eat, water we drink, soil and dust we come in contact with, and in consumer products.

Dioxins are a group of 75 related chemical compounds known as polychlorinated dibenzo-p-dioxins. Each of the 75 compounds differ in the number and location of chlorine atoms on a basic three-ringed structure of carbon, hydrogen and oxygen atoms. Furans are a group of 135 related chemical compounds called polychlorinated dibenzofurans.



Toxic forms of dioxins and furans are those containing 4 to 8 chlorine atoms, with four of the atoms in the lateral position (i.e. 2,3,7,8).

Green Facts

These effects are not limited to 2,3,7,8-TCDD. They can also be caused by high doses of the 16 other dioxins and furans of concern depending on their toxicity relative to 2,3,7,8-TCDD.

Effects on humans

Studies have been done on people who have been accidentally exposed to high levels of dioxins and furans - at work, as a result of improper waste disposal, or from eating contaminated cooking oil. Chloracne, a skin disorder, is the most common human health effect. Extreme exposures also lead to other effects on the skin, liver, immune system, reproduction system, senses and behavior.

The effects of long-term, low-level human exposure are still being investigated. Current scientific evidence does not indicate a link between normal, everyday exposure and long-term health effects such as cancer, coronary disease and impaired reproduction.

How are dioxins and furans produced?

Dioxins and furans are unwanted byproducts created in manufacturing other chemicals such as some disinfectants, wood preservatives and herbicides. They are also emitted during combustion processes such as the incineration of municipal and industrial waste, wood and gasoline burning.

Sources in Ontario

Herbicides and related chemicals, known to contain dioxins and furans, are no longer manufactured in Ontario. But the long-term effect of these manufacturing processes is still with us. Former U.S. pesticide manufacturing sites containing buried wastes contaminated with dioxins and furans continue to leach into the Niagara River. Some chemical industry and wood preservation sites in Ontario also contain dioxin and furan contaminated wastes.

In the past, the widespread use of PCBs was an important way for furans to reach the

environment. Today, PCBs are stored in contained facilities awaiting disposal and are only a source of furans through accidental leakage or fires.

Current sources of dioxins and furans include incinerators and other combustion processes, bleached kraft pulp and paper mills using chlorine and certain petroleum refineries.

Detecting dioxins and furans

The recent development of very sensitive and accurate analytical methods enables scientists to detect concentrations of dioxins and furans as low as parts per trillion and parts per quadrillion. At these very minute levels, dioxins and furans have been found in some soil, air, water, wildlife, food and human fat samples.

To understand these minute figures, just imagine a grain of salt in an Olympic-sized pool as a 'parts per trillion', or the area of a dollar bill compared to the area of Canada as a 'parts per quadrillion'.

Higher levels (in the parts per billion range) have been measured in chemical wastes and in sediment samples obtained near properties contaminated with industrial wastes.

How much are we exposed to?

A federal-Ontario assessment has estimated the average daily multimedia exposure (from air, water, food, soil, consumer products) of adult Canadians to dioxins and furans is about 2 to 4 picograms of 2,3,7,8-TCDD toxic equivalents (TEQ) per kilogram of body weight.

While human exposure is mostly from food, breathing urban air is also an important contributor. Drinking water and coming into contact with contaminated soils or consumer products provide far less exposure.

How much is safe?

Although recommended safe levels are usually developed based on the effects of 2,3,7,8-

Green Facts

TCDD, it is possible to calculate tolerable levels of exposure for all dioxins and furans.

This is done by taking the concentrations of the 17 most toxic dioxins and furans, multiplying each one by a toxic equivalency factor (TEF) – its toxicity relative to 2,3,7,8-TCDD – and adding up all the corrected concentrations expressed as 2,3,7,8-TCDD toxic equivalents (TEQ).

Animal studies and long-term studies on people who have been accidentally or occupationally exposed to dioxins and furans led a committee of scientific experts to conclude that the tolerable daily intake (TDI) of 2,3,7,8-TCDD TEQ for humans is 10 picograms per kilogram of body weight. This TDI was adopted by Canada in 1990.

What is Ontario doing to reduce dioxins and furans?

Ontario continues to reduce environmental contamination by dioxins and furans through a comprehensive program of regulatory, monitoring, abatement, research and education initiatives.

The province has developed multimedia guidelines that integrate limits for the intake of dioxins and furans from all sources (air, water, land, food, waste, consumer products) into a single, overall standard such as the TDI.

Dioxins and Furans of concern

Only 17 of all 210 dioxins and furans have four lateral chlorine atoms and are of concern. The table below lists the 17 compounds and their toxic equivalency factors relative to 2,3,7,8-TCDD. These factors are called the International Toxicity Equivalency Factors (I-TEF) and were developed by scientific experts in several countries. They were adopted by Canada in 1990.

	I-TEF
2,3,7,8-Tetrachlorodibenzo-p-dioxin	1.0
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	0.5
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	0.1
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	0.1
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	0.1
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	0.01
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin	0.001
2,3,7,8-Tetrachlorodibenzofuran	0.1
2,3,4,7,8-Pentachlorodibenzofuran	0.5
1,2,3,7,8-Pentachlorodibenzofuran	0.05
1,2,3,4,7,8-Hexachlorodibenzofuran	0.1
1,2,3,6,7,8-Hexachlorodibenzofuran	0.1
1,2,3,7,8,9-Hexachlorodibenzofuran	0.1
2,3,4,6,7,8-Hexachlorodibenzofuran	0.1
1,2,3,4,6,7,8-Heptachlorodibenzofuran	0.01
1,2,3,4,7,8,9-Heptachlorodibenzofuran	0.01
1,2,3,4,6,7,8,9-Octachlorodibenzofuran	0.001

Tetrachloro- means four chlorine atoms attached. Penta-, hexa-, hepta- and octo- means five, six, seven and eight, respectively. The other 193 dioxins and furans have negligible toxicities in comparison and are assigned a value of zero.

What are Ontario's standards for Dioxins?

Air:	Ambient Air Quality Criterion (24 hour)	– 5 picograms TEQ / cubic metre.
Drinking Water:	Interim Maximum Allowable Concentration	– 15 picograms TEQ / litre.
Surface Water:	A Canadian Water Quality Guideline is in preparation.	
Surface Soils:	Residential Soil Remediation Criterion	– 1000 picograms TEQ / gram.
	Agricultural Soil Remediation Criterion	– 10 picograms TEQ / gram.

Except for the water quality guideline which will protect aquatic life, all these standards are protective of human health over a lifetime of exposure.

Where can I find out more?

The following federal and provincial publications on dioxins and furans may be obtained through your local library, Ontario Ministry of Environment and Energy's Public Information Centre or Environment Canada.

Environment Canada/Health and Welfare Canada. (1990)

Canadian Environmental Protection Act. Priority Substances List Assessment Report No. 1, Polychlorinated Dibenzodioxins and Polychlorinated Dibenzofurans.

Catalogue No. En40-215/1E.

Ontario (1985)

Scientific Criteria Document for Standard Development, Polychlorinated Dibenzo-p-dioxins (PCDDs) and Polychlorinated Dibenzofurans (PCDFs).

Toronto, Ministry of the Environment. (Report No. 4-84).

Ontario (1988)

Polychlorinated Dibenzo-p-dioxins and Polychlorinated Dibenzofurans and other Organochlorine Contaminants in Food.

Toronto, Ministry of Agriculture and Food and Ministry of the Environment.

For more information on dioxins, furans and other topics, please contact:

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Glossary

dioxins

A group of 75 related chemical compounds known as polychlorinated dibenzo-p-dioxins.

furans

A group of 135 related chemical compounds known as polychlorinated dibenzofurans.

2,3,7,8-TCDD

The most toxic compound of the dioxin group, TCDD stands for tetrachlorodibenzo-p-dioxin.

TEQ

Toxicity equivalent (by weight) of 2,3,7,8-TCDD.

TDI

Tolerable daily intake. For humans, it is 10 picograms of 2,3,7,8-TCDD TEQ per kilogram of body weight. This means that a person weighing 70 kilograms can eat, drink, breathe or come into contact with a combined total of up to 700 picograms of 2,3,7,8-TCDD TEQ per day (about 0.007 millionth of a gram) with no harmful effects.

picograms

One picogram is 10^{-12} gram, or 0.000001 millionth of a gram.

TEF

Toxicity equivalency factor, used to calculate the amount of other dioxins and furans as if they were 2,3,7,8-TCDD.

I-TEF

International Toxicity Equivalency Factors

multimedia exposure assessment

Assessing multiple exposures through all environmental media (i.e. air, land, water, waste, food, etc.) so that limits can be set that do not exceed a single overall standard, such as the TDI, when all exposures are combined together.

